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ABSTRACT

A study was conducted to examine gender differences in computer attitudes and experiences of adolescents. A random, systematic sample of students (1,138) from five San Francisco Bay area high schools was surveyed for their uses of computers before and during their high school years. Four main categories of data were collected: (1) instructional and informal computer experiences of high school students; (2) students' attitudes toward computers; (3) social influences affecting computer use; and (4) student background and demographic data. Findings indicate that adolescent males had greater total exposure to computers, based primarily on higher enrollments in computer programming classes and participation in voluntary experiences, such as home computer use. Fewer gender differences were found in enrollment in classes using computers for purposes other than programming. Overall, males also held more positive attitudes of interest in, and confidence with, computers than did females. However, controlling for amount of computer experience indicated that males and females responded with similar levels of interest. Social influences, particularly those among peer groups, are explored as important factors for differential rates of participation in computer activities. It is suggested that the job of preparing male and female students for prospective career paths and helping them to realize the occupational utility of computer experience remains a challenge for our schools. A three-page list of references completes the document. (JB)

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GENDER AND COMPUTERS:

THE BENEFICIAL EFFECTS OF EXPERIENCE ON ATTITUDES

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ABSTRACT

This study examines gender differences in computer attitudes and experiences of adolescents. A sample of students from five Bay Area high schools was surveyed for their uses of computers before and during their high school years, in both formal instruction and informal settings. Adolescent males had greater total exposure to computers, based primarily on higher enrollments in computer programming classes and participation in voluntary experiences, such as home computer use. Fewer gender differences were found in enrollment in classes using computers for purposes other than programming. Overall, males also held more positive attitudes of interest in and confidence with computers than did females. Controlling for amount of computer experience, however, males and females responded with similar levels of interest. Social influences, especially those among peer groups, are explored as important factors for differential rates of participation in computer activities.

While much of the excitement surrounding microcomputers in education arises out of their potential cognitive benefits, concern is growing that the advantages offered by these technologies will not accrue to all social groups [1-3]. The media may be new, but they raise some distinctly familiar questions of equity in the availability and use of an important educational technology.

The faultlines of inequity are stratifying along two types of social divisions: wealth and gender. Computers require substantial financial investment and recent studies indicate that, predictably, schools and homes with higher socioeconomic status have been earlier adopters of microcomputers [4-6].

However, microcomputers raise a concern about equity that goes beyond the advantages of higher income or status. It is common to find more males than females, in various age groups, taking computer classes, attending computer camps, and indicating greater interest in computers in both home and school settings. In this study, a random sample of students from five Bay Area high schools is analyzed for gender differences in experiences with and attitudes towards computers.[1] Data reported here address descriptive differences in both experience and attitudes, as well as the role of experience as a predictor of attitudes.

These phenomena relating gender to technology recall issues familiar to the study of gender differences in mathematics and

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[1]This study was a project of the Education and Technology Panel of the Study of Stanford and the Schools. Funding was provided by the Lilly Endowment.

science achievement and participation. Research on the relationship of gender to the study of mathematics has been a vital and fertile field of study during the past decade. The following review focuses not only on early studies of gender differences in computer experience, but also refers to this larger literature on gender differences in mathematics achievement. Several of those studies are especially relevant in addressing what will be labelled as the "differential experience hypothesis."

REVIEW OF LITERATURE

Gender Differences in Mathematics Participation and Achievement

During the 1970s, the problem of gender differences in mathematics achievement was largely attributed to differential rates of enrollment in mathematics courses during the high school and college years. Recent analyses of data collected during the late 70s reveal that the gap in male/female enrollment was not as extreme as once believed. Studies of course enrollments at the high school level indicate a pattern of nearly equal percentages of male and female participation in lower level courses (algebra and geometry) with larger differences in more advanced courses, such as trigonometry, analytic geometry, and calculus. In their review of these studies, Chipman and Thomas concluded that "about 40% of those who approach college with the standard level of mathematics preparation are women. About 40% of women entering college are well-prepared in mathematics, having taken the standard four years of high school mathematics" [7, p. 6].

Gender differences in mathematics achievement generally have not been reported for children in the elementary grades [8].

Several studies of 13-year-olds, using data from the National Assessment of Educational Progress and the Women and Mathematics National Survey, found that females performed better on tests of computation and equal to or slightly below males in problem-solving items [9]. During the subsequent high school and college years, gender differences have been reported more frequently, with the most sizeable differences in the area of problem-solving skills. Perhaps the most striking findings come from mathematics scores on the Scholastic Aptitude Test (SAT) [10]. The average male score typically exceeds the average female score by 40 to 50 points, while verbal differences are minimal. The difference is acute among the highest-achieving group (scores greater than 700): that group contains four times as many males as females.

The "differential coursework hypothesis" put forth by Fennema and Sherman and others suggests that differences in achievement are a function of amount of preparation, typically measured through course enrollments [11,12]. Several studies support this hypothesis, finding that a large proportion of the difference in 12th-grade achievement scores is accounted for by differences in the number and types of mathematics courses taken by males and females [9,13].

Gender Differences in Computer Use

The following section reviews studies of gender differences in computer use, looking first at studies of participation in computer courses and other experiences and then at studies of achievement and performance in computer-based skills.

Studies of Enrollment and Participation

Similar to data on rates of female participation in mathematics, available data frequently indicate lower enrollment by girls and women in computer courses [14,15]. These studies most commonly examine enrollments in computer programming and computer science courses, reporting male/female ratios of 3/2 to upwards of 5/1, with higher proportions of males in more advanced programming classes. The fewer available studies of enrollment in non-programming courses suggest that gender differences are less striking in courses where computers are used for applications such as computer-assisted instruction, games, simulations, or word processing. In this last case, a female majority is often reported. Several studies have documented greater participation by males in informal learning settings, especially computer camps.

Linn and others at the Lawrence Hall of Science, University of California at Berkeley, studied student enrollment in BASIC courses at six California middle schools [16]. Sixty-four percent of the students were boys, a figure estimated by the researchers to reflect state-wide trends. Among 51,481 high school students in California enrolled in courses involving computers, 42% were female. Females comprised 86% of students in word processing courses and 37% in programming courses. This latter figure matches well with data from the National Longitudinal Study of 1980-82, where 40% of high school students taking a programming course were female [17]. The Lawrence Hall of Science offers its own computer courses for elementary and secondary school students. Over the past three years, only 25% of the

2,693 students were female. The level of female participation was highest for the introductory course (34%) and decreased for a course in intermediate BASIC (19%) [16].

The most current national data come from the Second School Uses of Microcomputers Survey conducted by Becker at Johns Hopkins University [18]. Data were collected in the spring of 1985 from primary computer-using teachers in a national probability sample of over 2300 elementary and secondary schools. Use by males was highest among voluntary computer activities before or after school, where teachers' estimates of percentage of male users was greater than 75% at both elementary and secondary levels. Female use was highest for word processing; females comprised nearly half of all students using word processors at both levels. A larger gender difference was found for programming uses at the elementary level, with females accounting for less than 20% of all programming students. At the secondary level, however, teachers reported nearly equal proportions of males and females taking programming.

In a survey of 23 computer camps, Hess and Miura [19] found that girls represented28% of the beginning and intermediate classes, 14% of advanced programming classes, and only 5% of high-level courses teaching assembly language. In a more detailed study of a single computer camp with 294 young people ranging in age from 7 to 19, 15% were girls [20]. Boys were more likely to have used computers longer and more frequently at both home and school and to be more proficient in programming at the start of camp.

Kiesler and Sproull at Carnegie-Mellon University have focused on sex differences in college students' uses of and attitudes towards computers [21]. Female college students at CMU were less likely to have had prior computing experience and to have played computer games and were more likely to encounter negative experiences in their first computing course at college. The researchers traced these differences to early development of male-female roles and behaviors in schools, video game arcades, and computer stores, where boys as young as the preschool age have been observed to monopolize computers and restrict their access to young girls.

Other researchers have also focused on the male-oriented culture that prevails in such settings, noting that the majority of computer games available for children favor "male" titles and themes of violence and competition [2,22]. One survey of videogame and computer use among fourth- through sixth-graders in the Bay Area found that boys played videogames more often, in both arcades and at home, especially games requiring aggressive competition ("like Space Invaders") [23]. The survey also found voluntary uses of computers to be higher among boys than girls, as measured through enrollment in optional computer courses and using a friend's computer.

Studies of Achievement

Assessing computer learning presents measurement challenges that are beginning to be addressed. A few studies have reported data on gender differences in performance on computer-based learning. The 1977-78 National Assessment of Educational Progress

contained several computer-related items in its mathematics assessment [24]. Overall, less than 25% of the 13- and 17-year-olds were able to correctly perform tasks such as reading a simple flowchart or completing a simple exercise in BASIC. Lower levels of computer ability as well as exposure were found for girls, minorities, rural students, and those in the southeastern states.

One of the most thorough studies of computer literacy among adolescents was conducted by the Minnesota Educational Computing Consortium (MECC) in 1979 [25]. The MECC survey found little evidence of sex differences in computer literacy among a sample of 8th- and 11th-grade students. Girls and boys were roughly equal in overall computer literacy as well as programming test scores. Girls outscored boys for items presented as word problems.

The Minnesota researchers attributed this equality in performance to the state's commitment to computer literacy, where equal access to computers for all students has been mandated. They speculated, however, that in most school districts where computers continue to be scarce resources, the enthusiasm with which boys participate in computer activities may lead to a loss of motivation on the part of females.

More recently, the California State Department of Education conducted a survey of 6th- and 12th-graders' knowledge of and attitudes towards computers [26]. Similar to the NAEP findings, knowledge of computer programming was low, although boys scored higher than girls at both grade levels. The higher scores among males were associated with greater exposure to computer experiences. In the Lawrence Hall's study of six California middle

schools, girls and boys possessed similar ability levels upon entering and completing a course in BASIC [16]. No gender difference in performance was found, despite the greater amount of overall computer experience and interest indicated by boys.

A study by Eastman and Krendl at Indiana University emphasizes the importance of locating gender differences in specific types of computer uses [27]. In a study of 8th-graders' accessing of an online video encyclopedia to write a science essay, few differences were found between male and female abilities with the computer task. In addition, gender differences at pretest in attitudes about boys' versus girls' abilities (boys holding superior beliefs about male abilities) were non-significant at posttest. The researchers attributed this change to the positive effects of engagement with computers in reducing sex stereotypes among both female and male students.

METHODOLOGY

The studies cited above suggest several hypotheses for testing in this survey. The first hypothesis is that males have acquired a greater amount of computer experience, taken as a global measure across various types of uses, both in school and through other voluntary activities in the home and other settings. Secondly, however, the literature recommends a closer look at gender differences in specific types of computer experiences. Studies of non-programming uses of computers have found smaller differences in enrollment between males and females. Thirdly, the literature emphasizes the importance of differential amounts

of experience in mediating gender differences in outcomes. Studies that controlled for amounts of mathematics course-taking often found minimal differences in male and female achievement levels.

With those considerations in mind, this survey was designed to investigate the computer uses and attitudes of a sample of high school students from five Bay Area High Schools. This study was conducted in May and June of 1983 by the Education and Technology Panel of the Study of Stanford and the Schools, a collaborative research effort between Stanford University and high schools in five Bay Area school districts. The five schools surveyed represented each of the five school districts.

A survey instrument was designed, pre-tested, and then administered during one class period at each of the five high schools. A random systematic sample of 1,138 students completed the questionnaire.

Four main categories of data were collected:

1) Computer experiences of high school students. These included classroom use of computers in elementary, junior high, and high school courses (for both programming and other applications); use of computers in other informal school settings, such as computer clubs; use of computers in homes, camps, or other out-of-school settings;

2) Students' attitudes towards computers, such as interest in computers, perceived skill with computers, and belief in gender equality in computer skill and use. Many of these items were adapted with permission from the survey conducted by the Minnesota Educational Computing Consortium [25];

3) Social influences affecting computer use, such as interest in, knowledge of, and encouragement of computers among family members and peers;

4) Student background and demographic data, such as future educational and occupational aspirations,

age, sex, ethnicity, and parental education and occupational level.

The characteristics and representativeness of these schools bears some comment. The five high schools studied are located in or near the Silicon Valley area, where a high percentage of jobs are related to the computer industries, where computer stores abound, and where media stories often involve high-technology issues. "Computer consciousness" is therefore higher in this area than in other regions of the country.

However, the "Silicon Valley influence" does not necessarily translate into enriched computer programs across the schools surveyed. The five high schools included one with a well-developed computer program, in which computers were used in programming, journalism, special education, mathematics, and science classes. In contrast, another school offered only a few courses that used computers occasionally in biology and business classes. While the home environments of these students may indicate a higher degree of computer awareness through, for instance, the nature of parents' occupations, these high schools did not obviously differ from many other high school districts in the quantity and quality of computer instruction offered during the 1982-83 school year.

RESULTS

This section first reports results of bivariate relationships between gender and measures of students' uses of computers, and between gender and students' attitudes towards computers. Next, a series of analyses using an index of overall computer experience are reported in which experience is used as a control-

ling variable to further test relationships between gender and attitudes towards computers. Finally, other data from the survey are presented to explore differential socialization patterns affecting the computer attitudes of high school males and females. These and other data from the survey are treated in greater length elsewhere [28].

Students' Uses of Computers

School Uses of Computers

Table 1 presents data for the total sample and by gender on measures of computer use before and during high school. These uses include both classes in computer programming and those in which some non-programming application was taught (e.g., word processing, data analysis, drill and practice in subject areas).

TABLE 1: STUDENTS' USE OF COMPUTERS IN SCHOOLS

	TOTAL SAMPLE N=1,138 %	BOYS n=595 %	GIRLS n=531 %	
Pre-high school use	25.5	27.1	23.7	
Pre-high school programming course	16.0	18.6	13.1	*
Current enrollment in a high school programming class	6.5	8.3	4.6	*
Semesters of high school programming				
One	9.0	9.6	8.4	
Two	3.0	4.3	1.5	
Three or more	1.7	2.6	0.4	**
Enrollment in high school non-programming class	18.2	17.9	18.6	

Notes:
1. Missing cases diminish sample sizes by at most 10%.
2. Probability levels for significance tests: *p<.05, **p<.01
3. Significance test for semesters of high school programming reflects three levels of enrollment.

Computer programming is the one use of computers that most

clearly differentiates males from females. A higher percentage of boys enrolled in programming courses both before and during high school than did girls. The ratio between male and female enrollments in high school programming rose with the level of difficulty of the course. In other data from the survey, males also intended to take a higher number of programming courses than did females.

However, differences were not significant between male and female enrollment in other high school courses that utilized computers, nor between percentages of males and females who had used computers for any purpose before coming to high school. Other data from the survey indicated no gender difference as well in the average number of high school mathematics and science courses taken.

While a higher proportion of males enrolled in computer programming classes, males and females reported similar levels of performance on one measure of programming skill. Students who had taken a programming course during high school were asked to report their grade from the most recent programming class taken. Boys' mean grade on a scale of one (high) to seven (low) was 1.89; girls' mean grade was 2.03, $\underline{t}(162)=0.58$, p=ns.

Availability and Use of a Home Computer

Given the location of students' families in or near the Silicon Valley, ownership of home computers was expected to exceed national averages and to be among the nation's highest. Among the total sample, 21% of students reported ownership of a home computer, more than double the 8-10% estimates cited for the

nation during that period of mid-1983 and higher than the 13.1% national figure reported nearly two years later in February, 1985 by Dataquest [29].

More males than females in this sample reported the presence of a home computer (23.7% of males, 18.1% of females, $\chi^2(1)=4.50$, $p<.05$). These higher rates of home ownership among males may reflect greater parental encouragement as well as a higher level of interest among high school males. There were no gender differences in presence of other electronic technologies in the home, such as cable television (52.9%), videocassette recorders (33.0%), or videogame players (58.3%).

For students with home computers, a more critical difference was found in their amount of use. Boys used their home computers an average of 6.1 hours per week, while girls had an average weekly use of 3.6 hours, $t(204)=2.76$, $p<.01$.

Use of Computers in Other Informal Settings

Data were also gathered on students' use of computers in other informal settings outside the school and home (e.g., use of a computer in a public library, at a friends' house, or parent's office). Given the difficulties of more precise measurement of frequency and duration of such experiences, the survey simply asked students whether they had ever participated in these computer activities. A higher percentage of boys reported using a friend's computer (37.6% of males, 29.9% of females, $\chi^2(1)=6.83$, $p<.01$) and belonging to a computer club at school (9.6% of males, 5.6% of females, $\chi^2(1)=5.22$, $p<.05$). No differences were found between boys' and girls' use of a computer in the public library

(10.3%) or at a parent's office (16.0%). Incidence of attendance at computer camps was too low (1.4% of sample) to enable interpretation of gender differences.

Students' Attitudes Towards Computers

A factor analysis (principal components with varimax rotation) was performed on the 32 attitude items and confirmed the presence of five dimensions of computer attitudes. The five factors were named as: 1) Computer Interest (general interest in and attraction towards computer activities); 2) Gender Equality in Computer Use (agreement with statements that women and girls can be as skilled with computers as men and boys); 3) Computer Confidence (self-confidence in skill with computers); 4) Computer Anxiety (perception that computers are difficult to master and raise feelings of inadequacy); 5) Respect Through Computers (belief that computer skill leads to respect from parents and peers). While confidence and anxiety may appear to be opposite measures of the same construct, they are retained for separate analysis here. Items in the Computer Anxiety index expressed a more emotional dimension of doubt or discomfort, while the Computer Confidence items did not use affective terms in asking for appraisals of ability and skill relative to others.

Based on the factor analysis, additive indexes corresponding to these five dimensions were computed. (Reliabilities for these indexes are given in Table 2). Each index ranges from one (negative) to five (positive). Table 2 presents the results of t-tests of differences between the means for boys and girls on these five indexes.

TABLE 2: STUDENTS' ATTITUDES TOWARDS COMPUTERS

	BOYS n=595	GIRLS n=531	
Computer Interest (6 items)	3.87	3.76	*
Gender Equality (5 items)	3.80	4.39	***
Computer Confidence (3 items)	3.00	2.66	***
Computer Anxiety (4 items)	2.26	2.44	***
Respect Through Computers (2 items)	2.88	2.56	***

Notes:
1. Attitude indexes computed on a five-point scale (5=high, 1=low)
2. Missing cases diminish sample sizes by at most 10%.
3. Probability levels for significance tests: *p<.05, **p<.01, ***p<.001
4. Reliabilities for attitude indexes, using Cronbach's alpha, were: Computer Interest .90, Gender Equality in Computer Use .80, Computer Confidence .73, Computer Anxiety .78, and Respect Through Computers .88.

Males exhibited more positive attitudes towards computers on four of the five scales: Computer Interest, Computer Confidence, Computer Anxiety (lower), and Respect Through Computers. However, the largest difference was for girls' higher level of agreement with statements of gender equality (e.g., agreement with "women can do as well as men in computer careers," disagreement with "the boys in my school are better with computers than the girls"). The findings present a contrast between girls' strong feelings that females are and should be as competent with computers as men and their more negative feelings regarding personal involvement with computers. This ambivalence concerning females' strong beliefs in social equality but diminished personal interest and confidence has been described as a "We can but I can't" attitude.

Further analyses attempted to control for amount of experience in examining gender differences in attitudes. These analyses pose a variant of the "differential coursework" hypothesis--what can be viewed in broader terms as a "differential experience" hypothesis. For these analyses, experiences are taken as predictors of attitudes, viewed as dependent variables. The assumption is that attitudes and beliefs regarding computers are enduring personality qualities that "depend on" the acquisition of experience with computers. While the opposite causal direction also applies--that those with predisposing attitudes are led to engage in or avoid computer experiences--the theoretical approach adopted here is that attitudes function as outcomes of experience.

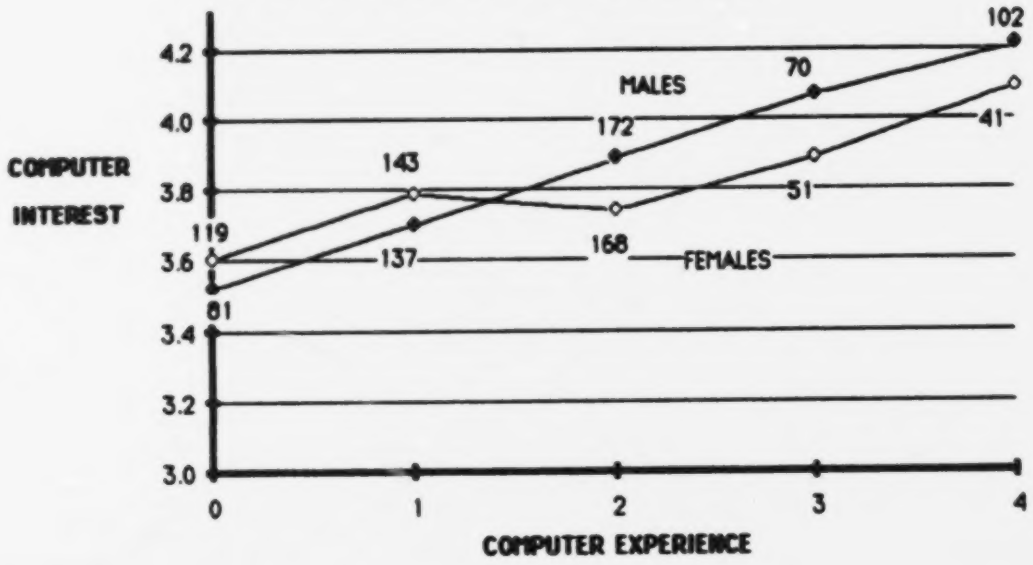
Are the more positive attitudes of high school boys associated with a greater degree of experience with computers? Conversely, can females' less positive attitudes be viewed as a function of less experience? Or, given similar amounts of experience with computers, are males still more likely than females to respond with a higher level of interest?

A single Computer Experience index was constructed to represent an overall measure of a student's experience with computers. Constituent variables included those individual measures of computer use reported above, including enrollment in school courses using computers (both programming and non-programming, before and during high school) as well as informal uses in home, at a library, in a computer club, etc. The index was weighted in favor of computer experiences offering more

substantial exposure to the technology (e.g., maximum weight was given to high school programming courses).

Figures 1 through 3 illustrate group means for males and females in Computer Interest, Confidence, and Anxiety, controlling for five levels of Computer Experience (0=no experience, 5=highest level of experience). Numbers at each mean denote subsample sizes.

FIGURE 1: COMPUTER INTEREST
BY SEX AND COMPUTER EXPERIENCE



Analysis of variance for group means represented in Figure 1 resulted in a main effect for Computer Experience, F (4,1074)=13.12, $p<.001$, but not sex, F (1,1074)=0.80, p=ns. The interaction of Computer Experience and sex was not significant. These findings suggest that interest in computers, as a function

of experience with the technology, behaves similarly for both males and females. While causality cannot be determined on the basis of these data, the theoretical interpretation proposed is that both adolescent males and females "respond" similarly to increases in computer experience with increased positive interest. The main obstacle to a higher level of female interest lies in the willingness to engage such experiences more frequently. As Elizabeth Fennema has stated for gender differences in mathematics, "The problem with girls is not the ability to learn math, but the willingness to study math."

Figure 2 indicates that the attitude of Computer Confidence behaves somewhat differently. Here, the analysis of variance resulted in main effects for both Computer Experience, F (4, 1068)=44.08, $p<.001$, and sex, F (1,1068)=23.46, $p<.001$. Even controlling for similar amounts of experience, males still were more self-confident about their abilities with computers.

FIGURE 2: COMPUTER CONFIDENCE BY SEX AND COMPUTER EXPERIENCE

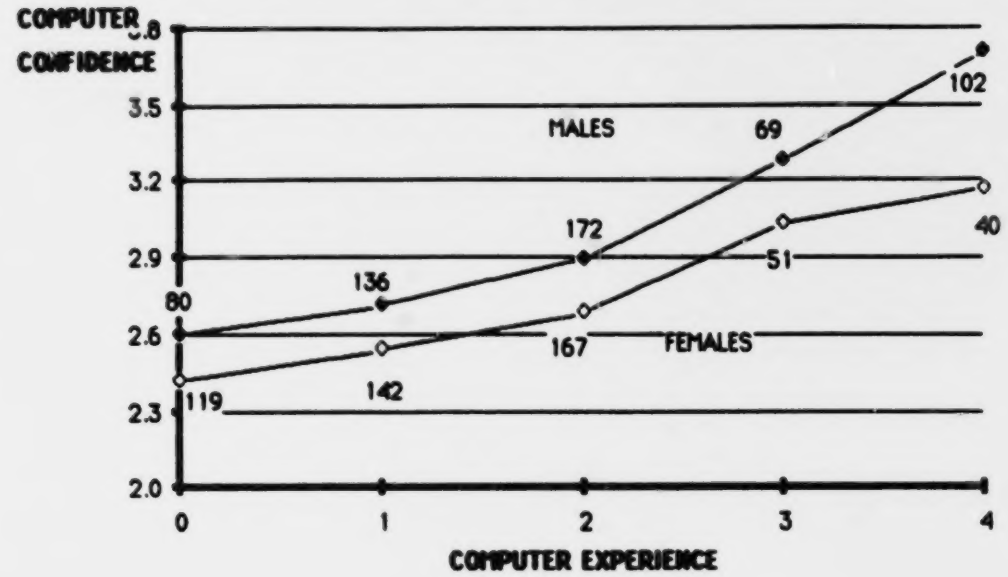
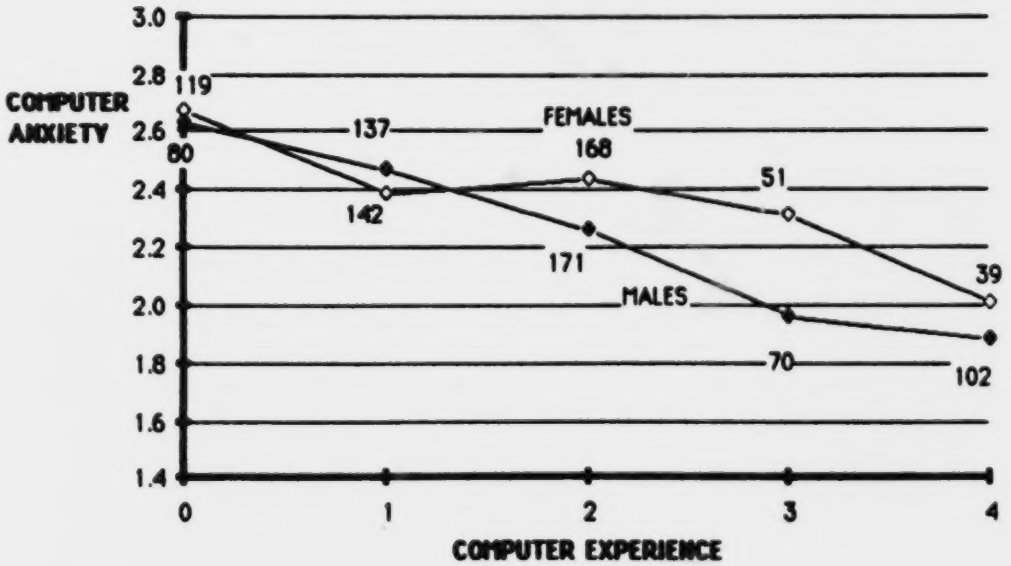


FIGURE 3: COMPUTER ANXIETY BY SEX AND COMPUTER EXPERIENCE



Findings based on Figure 3 for Computer Anxiety roughly parallel those for Computer Confidence. Analysis of variance resulted in main effects for both sex, F (1,1069)=5.02, $p<.05$, and Experience, F (4,1069)=22.20, $p<.001$, with a non-significant interaction term. For both Computer Confidence and Anxiety, it is interesting to note that the greatest gender differences are found at the higher levels of Computer Experience. Males with the most experience responded with more self-confidence and less doubt about their abilities with computers than females with similarly high levels of experience. Males and females at lower levels of experience showed smaller differences in less confidence and greater discomfort with computers.

These findings are consistent with studies of adolescents' attitudes towards mathematics, where males often report higher levels of confidence in their abilities than do females [11, 30]. Confidence may not necessarily be associated with higher achievement; several of these studies report higher levels of male confidence among males and females performing at similar levels. However, to the extent that confidence is linked to persistence and the willingness to continue in the study of a subject, a gender difference in confidence with computers may present a significant attitudinal problem.

Further analyses explored differences in female vs. male perceptions of the nature of computer use. One explanation put forth for lower levels of female participation in mathematics is the perception of mathematics as a sex-typed domain. Under this logic, because females believe that males are more successful in

mathematics, they avoid its study with greater frequency. Males adopt the opposite strategy, approaching mathematics with greater interest and persistence based on expectations of superior ability.

These data offer little support for such beliefs among females regarding their abilities with computers. As shown in Table 2, both males and females generally agreed with the attitude of Gender Equality in Computer Use, composed of items such as "Women can do as well as men in computer careers" and "The boys in my school are better with computers than the girls". The striking finding is the intensity of such beliefs among females of all types, defined by levels of academic achievement, parental education, and educational and occupational aspiration. Females consistently agreed more strongly with this attitude than did comparable males.

Another explanation targets the role of peer groups in socializing adolescent males and females towards different interests in mathematics, science, and technology. Data from this study support this explanation. High school boys more often reported having friends who were knowledgeable about and encouraged computer use; 47.3% of the boys reported having a friend who was knowledgeable about computers, compared with 36.5% of girls, $\chi^2(1)=11.14$, $p<.001$. Similarly, 38.1% of the boys but only 26.2% of girls responded that their friends had encouraged use of computers, $\chi^2(1)=15.23$, $p<.001$. Comparable differences were not found for family members' (i.e., mother's, father's, or siblings') knowledge of or encouragement towards computers.

Other data from the survey indicate that male and female

friendship networks contained a majority of same-sex peers, suggesting that males are sharing knowledge and encouragement concerning computers more often with other males than females. Peers may not only model computer knowledge and encouragement, but can also communicate approval and confer status regarding "approved" behaviors. As shown in Table 2, boys agreed more strongly than girls that computer skill could be one source of respect from peers and parents.

DISCUSSION

Consistent with some earlier studies, this survey found several expected gender differences in computer use favoring males. Adolescent boys were more likely to have taken a computer programming course before and during their high school years. Computers were more frequently found in boys' homes and were more frequently used at home by boys than by girls.

However, no difference was found in usage based on more general applications of computers. Gender differences were not significant among male and female students enrolled in any pre-high school course using computers as well as high school courses offering non-programming applications (including diverse uses from drill-and-practice in remedial classes to word processors in business and vocational subjects). This finding points to the importance of locating gender differences in computing by type of use.

Overall, adolescent males had more favorable attitudes about computers, based on attitude indexes measuring general interest and perceived skill. Controlling for amount of experience, how-

ever, differences were not found in levels of interest in computers among males and females with similar amounts of exposure to the technology. Males, especially those with the most experience, continued to report greater confidence and less anxiety with computers than females with similar amounts of experience.

These results suggest that a chief source of gender differences in attitudes is the greater willingness of males to participate in computer experiences. Contrary to more traditional explanations, females in this sample did not view computers as representing an alien domain in which women and girls held less chances for success. Instead, these young women had strong convictions regarding equality of skill and ability with computers between men and women.

Factors in the social environments of adolescent males and females presented more plausible explanations for differing rates of participation. High school males reported stronger presence of friends and peers who served as models for expertise and encouragement regarding computers. They were also more likely to believe that skill with computers was a source of respect from peers and parents. This study extends the notion of "separate cultures" of younger girls and boys into the culture of computing among adolescents [31]. The development of skill with computers is more socially approved and offers more social incentives in the culture of adolescent males than females. These stronger male bonds surrounding computer use may also act to develop and reinforce males' greater self-confidence with the technology.

Given the finding that experience with computers leads to

more positive attitudes regarding the technology, the crucial question becomes how to attract more females into computer experiences, through enrollment in formal instructional experiences as well as involvement with computers in the home and through other informal opportunities. These results suggest that intervention strategies emphasizing gender equality issues may not translate into personal action for many female adolescents. Judging from this sample, high school girls already hold strong beliefs in female abilities with computers.

This study recommends closer attention to processes of social influence by which peer groups affect attitudes and behaviors relative to computers. Further research can profitably be devoted to investigating differences in the "subjective task values" that females and males attach to their activities [32]. For instance, if girls believe that computer work is necessarily isolating and devoid of interaction with others, it is possible to structure computer experiences to offer a greater degree of peer collaboration. Creative use of peer tutoring arrangements may well contribute to enhancing girls' confidence in their computer abilities.

This study also suggests that subject-matter courses in English, mathematics, science, history, and other subjects are introducing female high school students to computers in greater numbers than computer programming classes. In these courses, the utility of the computer in the learning of subject-matter content is highlighted. Such courses may provide a more direct avenue to encouraging females' computer interests than the more technical emphasis in programming courses. At the same time,

equality of gender participation in programming courses should remain a goal, especially in light of the potential of programming skill to contribute to planning and problem-solving skills not as clearly activated through other types of computer use.

The relationship of gender to computers is changing, in response to social as well as technological change. Equity in computer use will benefit from advances in female participation in mathematics and science through the 1970s and 1980s, part of a larger movement towards equity in other sectors of the labor force as well. However, the job of preparing male and female students for prospective career paths and helping them realize the occupational utility of computer experience remains a challenge for our schools.

Changes in computer technology can also be a force for increased equity in computer use. The proliferation of computer applications, from graphics to databases to networks, can invite greater participation from females and other social groups less attracted to computers in their traditional form as computing machines.

However, in order for these new generations of computers to reach our younger generations of students, the classroom will need to keep closer pace with developments in hardware and software. Much of this software may not bill itself as ostensibly educational, but may be intended for business, scientific, or artistic uses. Educational policies and practices designed to broaden the use of computers beyond the confines of much of current practice (i.e., computer literacy, programming) into

these "real-world" applications will help females and males alike to see the relevance and attractiveness of this new technology.

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